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# Aurora's Danish power forecast (with an increasingly uncertain future)

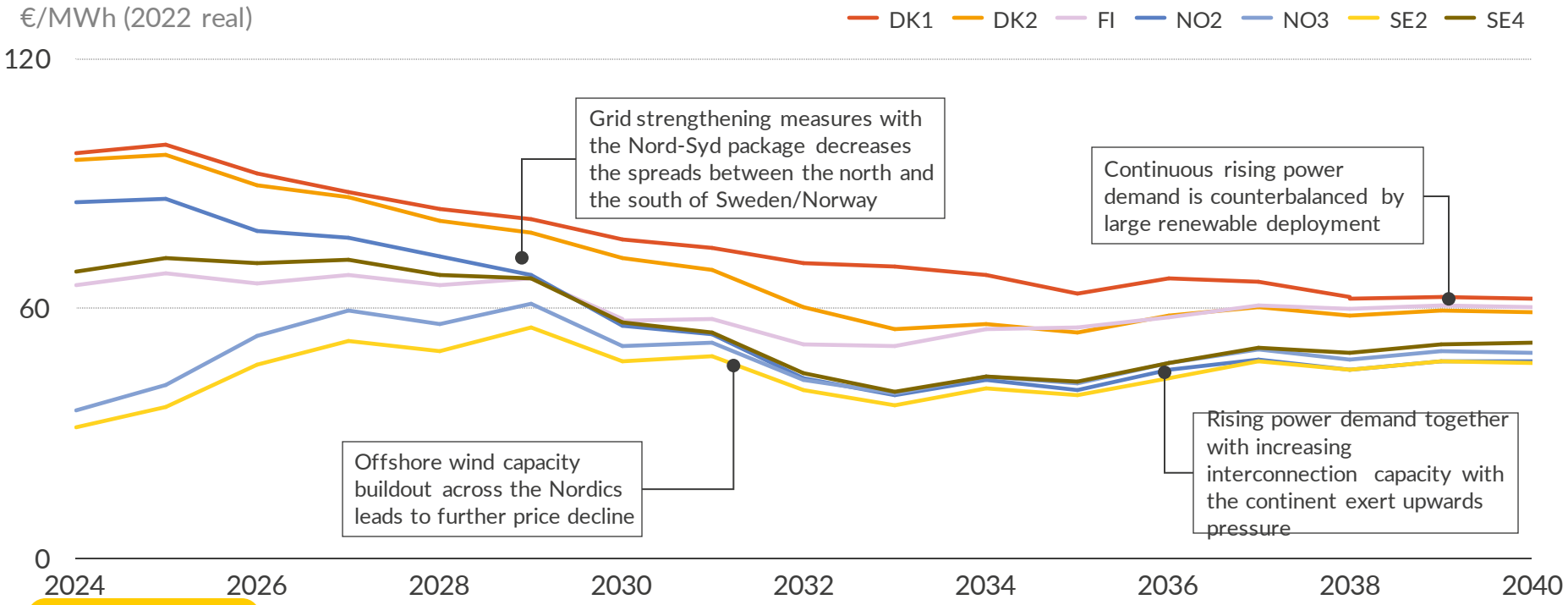
Prepared for Montel Danish Energy Day

Aarhus, 13th March

*Published in January 2024*

# Prices drop in most zones until the early 2030s with lower gas prices and large-scale offshore wind buildout, remaining relatively stable thereafter

**Power price per price zone**
€/MWh (2022 real)





**Phases of forecast**

- Prices drop as gas markets rebalance by the end of 2020s.
- Grid buildout leads to convergence of Northern and Southern zonal prices.
- Offshore wind buildout across the Nordics leads to further price decline up to the early 2030s.

- Rising power demand and CO2 prices cause power prices to increase in almost all zones while DK prices decline due to offshore capacity coming online.
- Total interconnection with the continent grows to 16 GW (20% increase) by 2040, exerting upward pressure on Nordic prices.
- Large RES deployments counterbalance power price rises in the face of rising power demand.
- Northern Swedish prices remain discounted given a large wind buildout.

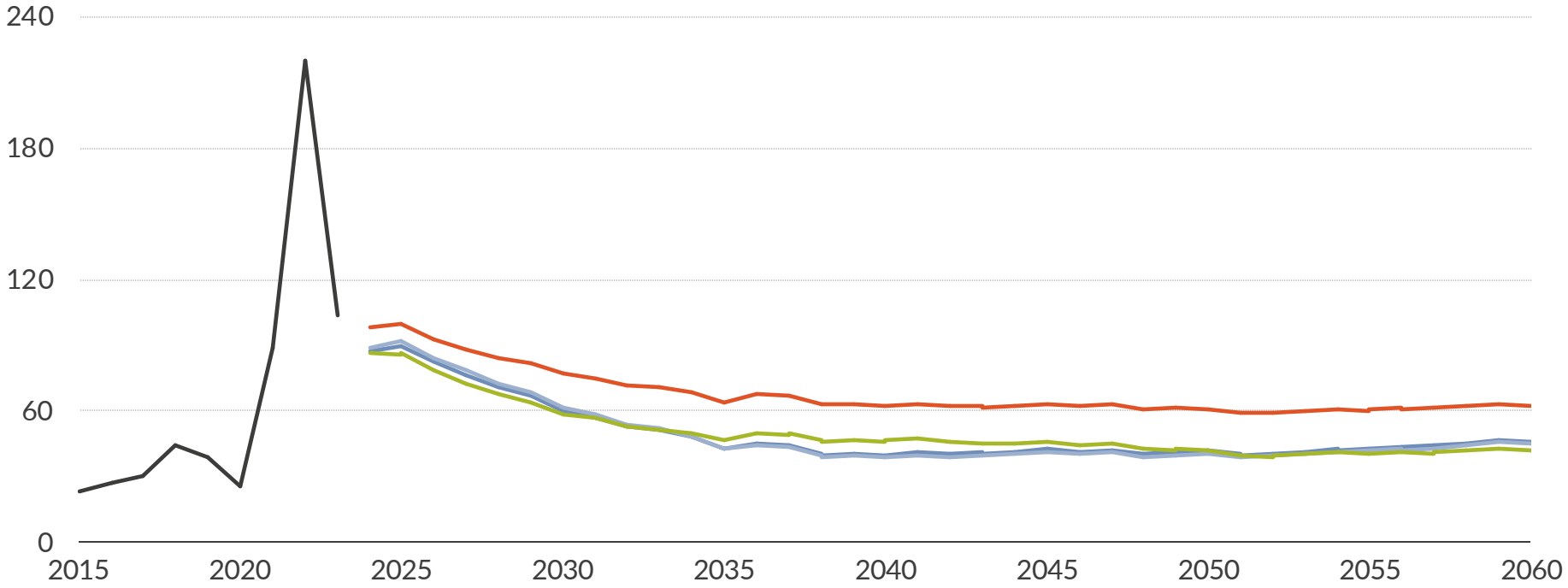
Sources: Aurora Energy Research

Published in January 2024

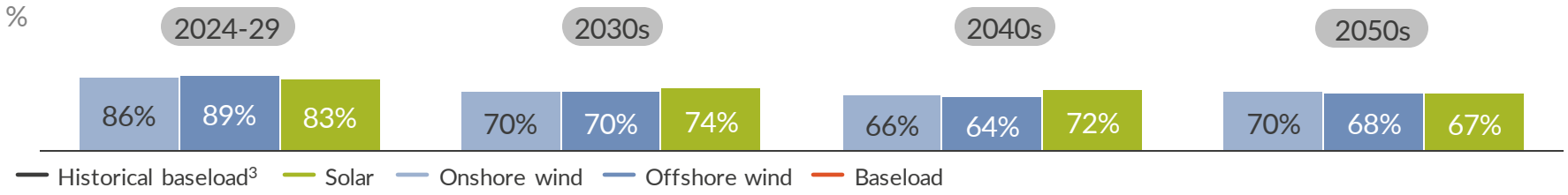
# In DK1, offshore wind build-out lowers baseload and capture prices; solar capture rates drop due to cannibalisation from German solar

**Baseload and renewables capture prices[1]**
€/MWh (real 2022)

**Price zone:** DK1




**Renewables capture rates[2]**




1) Capture prices are uncurtailed generation-weighted fleet average; 2) Capture rate is the capture price divided by the baseload price; 3) Including historical prices up to 2023-12-20.

Sources: Aurora Energy Research; Nordpool

## Outlook for renewables

### Onshore wind

- The capture rate for onshore wind follows the offshore capture rate as production is highly correlated.

### Offshore wind

- Offshore wind's capture rate relative to baseload becomes lower throughout the 2020s as more offshore capacity is installed.
- Offshore wind capacity is expected to almost quadruple due to the energy islands that are anticipated in the 2030s.

### Solar

- Solar power capture rate is decreasing as installed capacities amplify price cannibalisation.
- Proximity to zones with higher solar capacity, such as Germany, amplify price cannibalisation.

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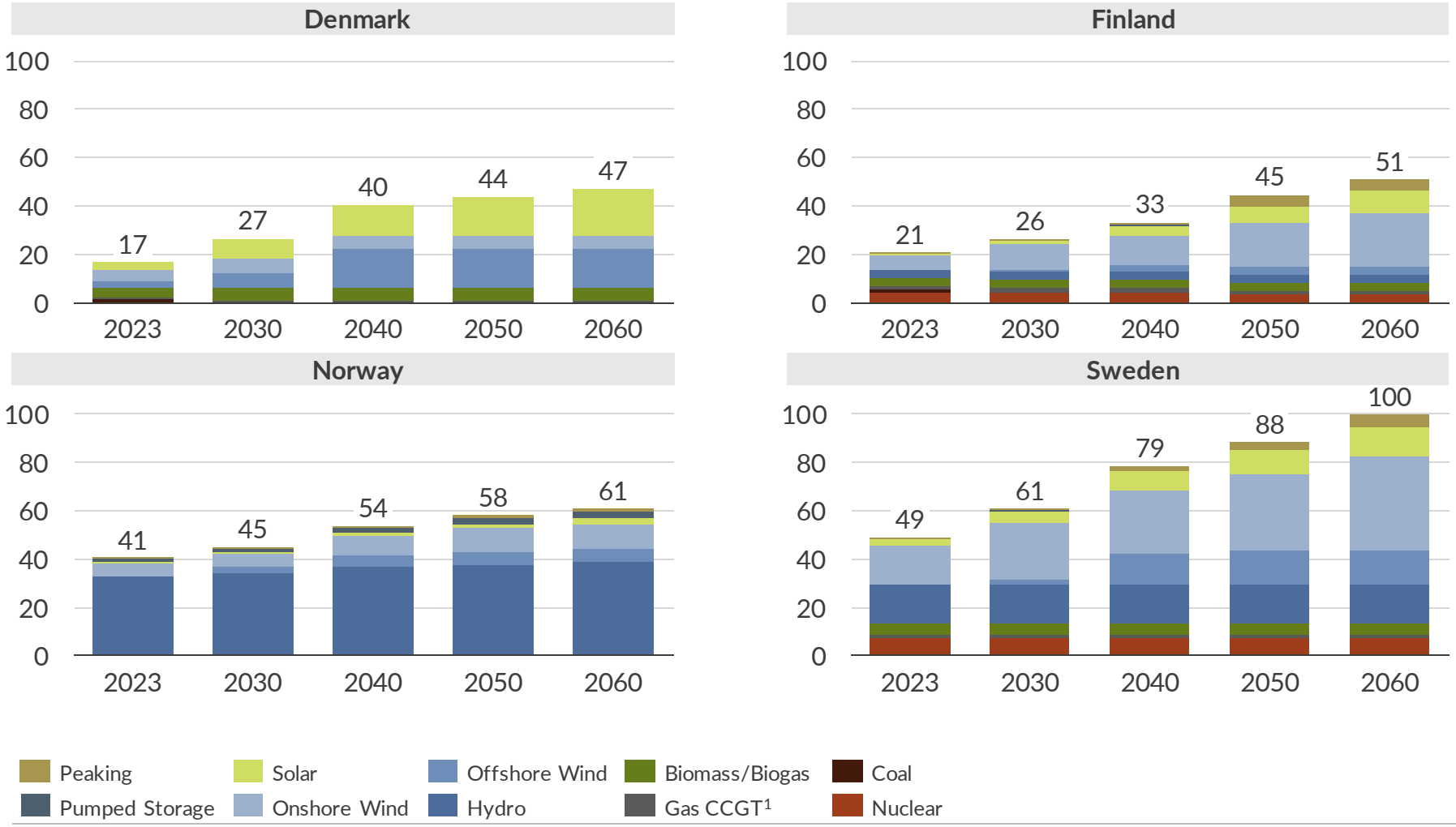
# Danish, Finnish and Swedish power systems undergo the largest transformations, with wind and solar providing the bulk of supply by 2060

**Installed capacity by country**

GW




1) Including gas OCGT, oil peakers, and hydrogen peakers

Sources: Aurora Energy Research

**Onshore wind**

- Large merchant additions in Sweden and Finland yet limited for Norway with needs for reform of licensing.

**Offshore wind**

- Denmark & Sweden sees the largest offshore deployment, reaching 16 GW in the 2040s.

**Solar**

- Large merchant and behind-the-meter additions in Denmark, Finland and Sweden, especially post 2030.

**Hydropower**

- Only Norway sees a buildout of reservoirs and pumped hydro, as environmental concerns restrict deployment in Finland and Sweden.

**Nuclear**

- Finnish nuclear capacity fully built out by 2033.
- Swedish nuclear extension extends lifetime and pushes phase out to after 2060.

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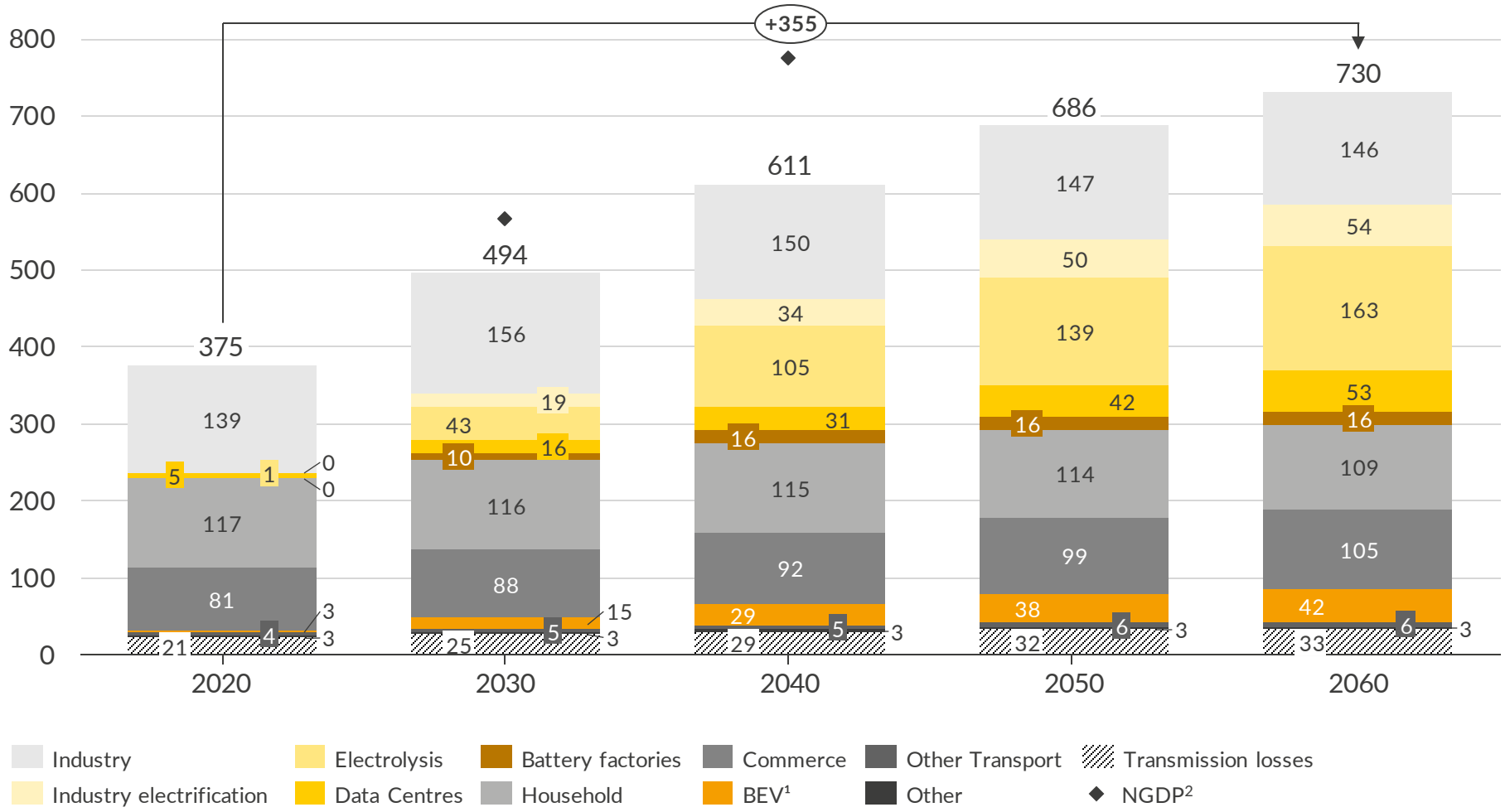
# Power demand nearly doubles due to electrification of transport, industry, data centres, battery factories and hydrogen production

**Electricity consumption forecast for the Nordics**

TWh




1) Battery electric vehicles; light and heavy transport, 2) Nordic TSOs' estimate of demand development published in Nordic Grid Development Perspective 2023

Sources: Aurora Energy Research; Nordic Grid Development Perspective 2023

## Comments

- Power demand from electrolysis experiences the largest uptake in demand 2030-2040, as the Nordics become a significant hydrogen-exporting region
- Industry demand increases in line with GDP growth until 2040 before it decreases due to efficiency gains
- An increasing part of currently gas fired industry processes get electrified
- Demand from data centres grow in line with computing demand, energy demand per server and favourable geographical conditions
- Battery factory demand increase based on projects announced until 2030 after which it increases in line with BEV sales in Europe

# Implementation of bidding zones is seen as a solution to structural power grid congestion in Europe and contributes to increased renewables implementation

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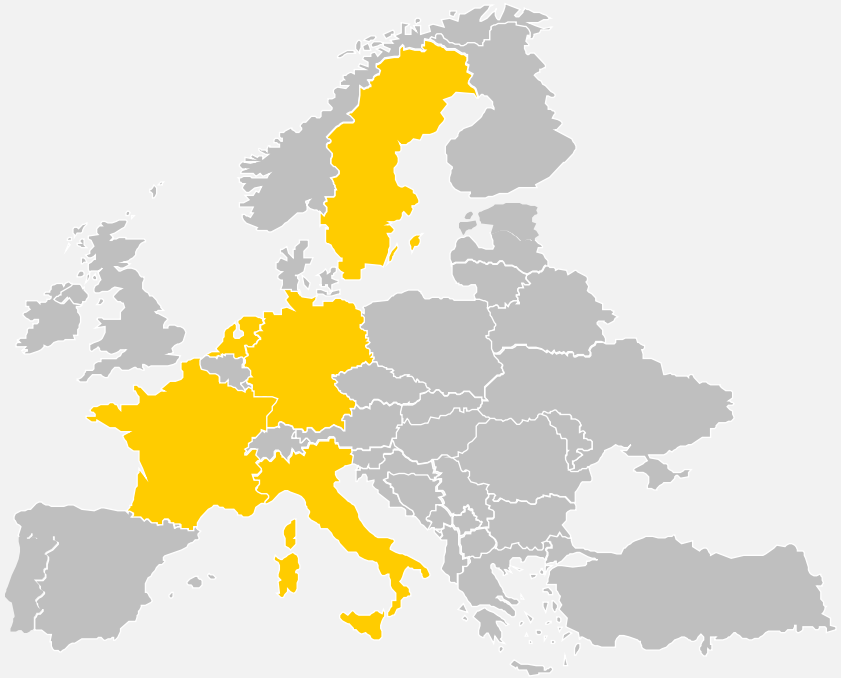
## Bidding Zone Reviews on the European level

- The EU Clean Energy Package requires ACER to assess energy market efficiency and to review current bidding zone configurations **every three years.**
  - In case of inefficiencies, ACER can request Transmission System Operators (TSOs) to evaluate and make proposals for an alternative BZ configuration.
- Five Bidding Zone Reviews (BZRs) are currently ongoing with the purpose to increase economic efficiency and cross-zonal trading.
- The countries undergoing a BZR are:
  - **France, Germany, Italy, the Netherlands and Sweden.**




Sources: Aurora Energy Research, ACER, ENTSO-E, Svenska Kraftnät

# Denmark is establishing a new bidding zone DK3 at the Bornholm Energy Island with interconnection to Zealand (DK2) and Germany

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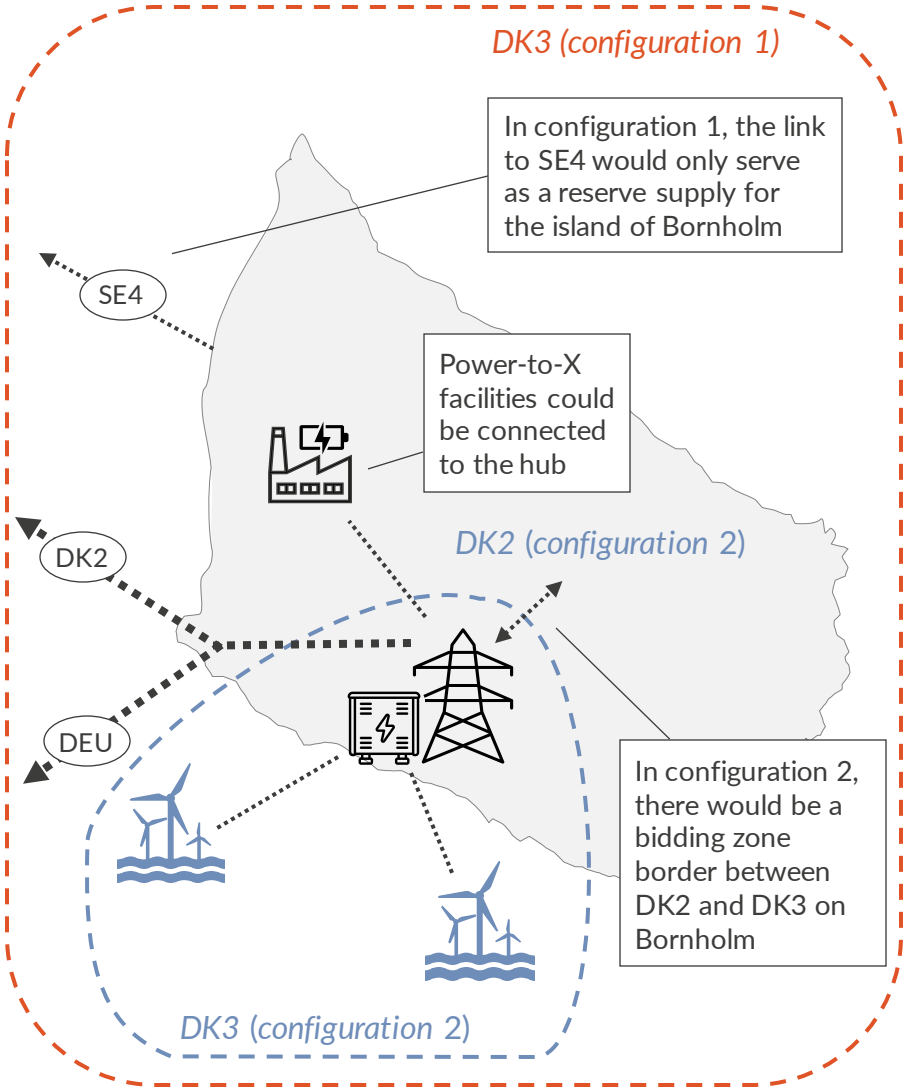
### Bornholm Energy Island

- The Bornholm Energy Island project aims to combine 3.2–3.8 GW of offshore wind capacity into a single hub on the island of Bornholm.
- The generated electricity is converted into HVDC and transported via a 525 kV hybrid interconnector to onshore substations in Germany and DK2.
- The interconnection capacities to Germany and DK2 are expected to be 2 GW and 1.2 GW, respectively.
- Denmark is also planning the North Sea Energy Island, the offshore wind capacity of which could grow up to 10 GW in the long

### Establishing the new price zone DK3

- Energinet expects a structural bottleneck to emerge between the Bornholm Energy Island and current DK2, which obliges the TSO to revise the bidding zones → Energinet proposes establishing a new bidding zone DK3.
- The new bidding zone will come into force when Bornholm Energy Island comes into operation.
- The decision whether the island of Bornholm will be included in DK3 or remain part of DK2 is expected in 2024.
- DK3 would form a new LFC[1] area within the existing LFC block.




### Pros and cons of establishing a new price zone for an energy island

| + | − |
|---|---|
| ▪ Avoiding structural congestion within a single price zone | ▪ In the case of Bornholm, increased market risk for assets located on the island |
| ▪ Improved price signals | ▪ Energy island price zone has volatile prices and is more often in imbalance |
| ▪ Oversupply together with congestion can create favourable conditions for hydrogen production within the new price zone | ▪ There is very little inertia in the system, imbalances need to be dealt with immediately |

1) Load Frequency Control

Sources: Aurora Energy Research

*Based on October 2023 Report*

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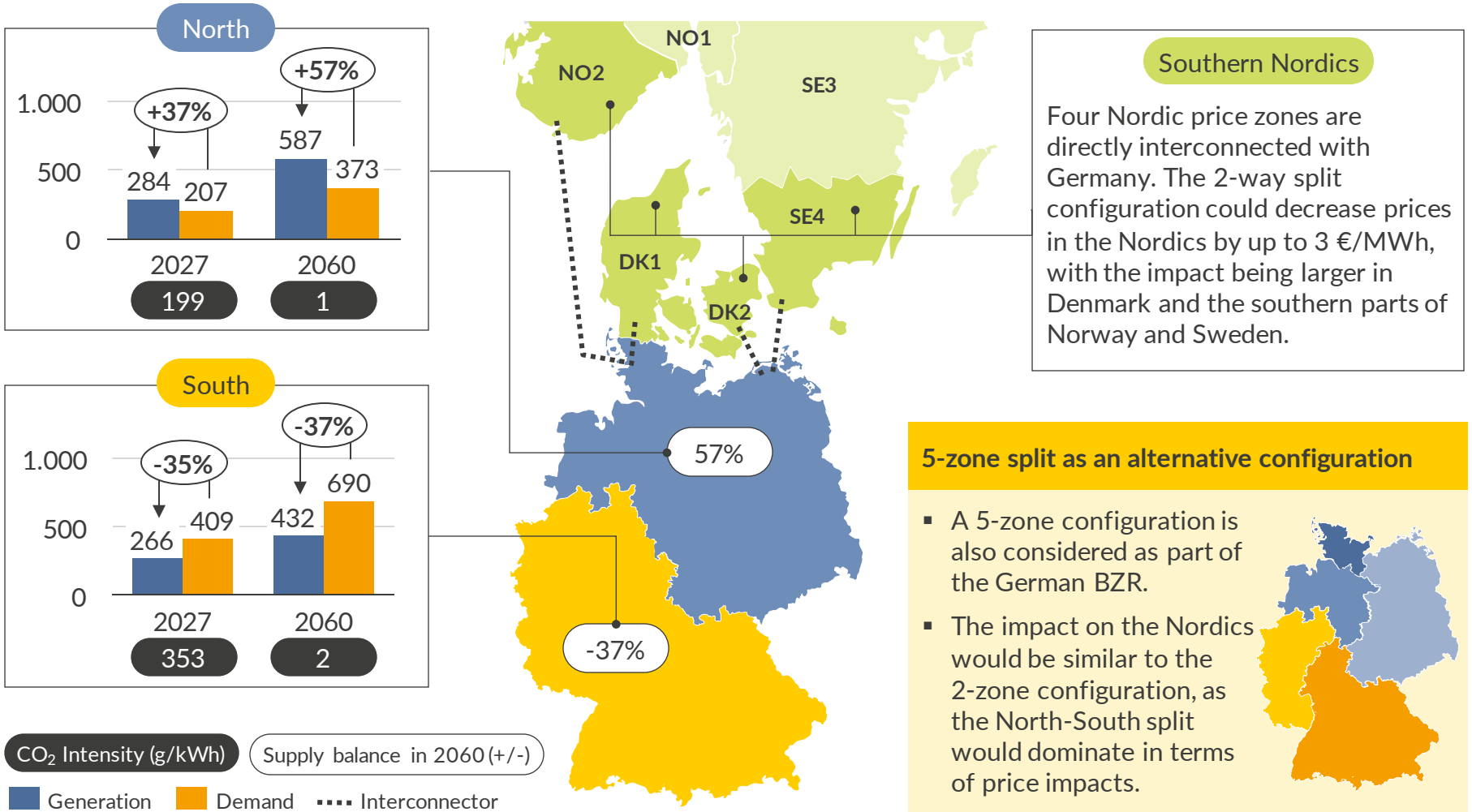
# A 2-zone split in Germany decreases power prices in North Germany, which impacts the Nordics due to the direct interconnectivity

**Map of zones in 2-zone split including generation and demand per zone**
TWh




## Southern Nordics

Four Nordic price zones are directly interconnected with Germany. The 2-way split configuration could decrease prices in the Nordics by up to 3 €/MWh, with the impact being larger in Denmark and the southern parts of Norway and Sweden.

## 5-zone split as an alternative configuration

- A 5-zone configuration is also considered as part of the German BZR.
- The impact on the Nordics would be similar to the 2-zone configuration, as the North-South split would dominate in terms of price impacts.



- The current oversupply of 37% in North Germany is due to a lower population density, a smaller industrial demand and high renewables potential, especially for onshore and offshore wind.
- In South Germany, there is average undersupply of 35% as:
  - Industrial centres have historically been located in the South and the West.
  - There is lower technical and economic potential for higher load factor technologies such as onshore and offshore wind.
- Due to higher share of gas and coal generation in the South, the emission intensity is 1.8x higher compared to the North in 2027.

Sources: Aurora Energy Research

# Key takeaways

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1. Power prices are dropping as the European gas markets are rebalancing after the energy crisis while grid buildout lead to con vergence between the norther and the southern zones in the Nordics. Furthermore, offshore wind buildout is pressuring prices downwards throughout the course of the forecast.

2. Danish, Finnish and Swedish power systems undergo the largest trans- formations, with wind and solar providing the bulk of supply by 2060. Offshore developments in Denmark, Sweden and Germany pushed capture rates downwards due to an increased cannibalization effect from neighboring zones.

3. Implementing Bidding Zones in Germany would result in a split between the oversupplied North and the undersupplied South. This could decrease Nordic power prices by up to 3€/MWh due to high interconnectivity with the cheaper northern Germany. Introducing bidding zones for the first time has a larger impact than a reconfiguration of existing zones, such as in Sweden.

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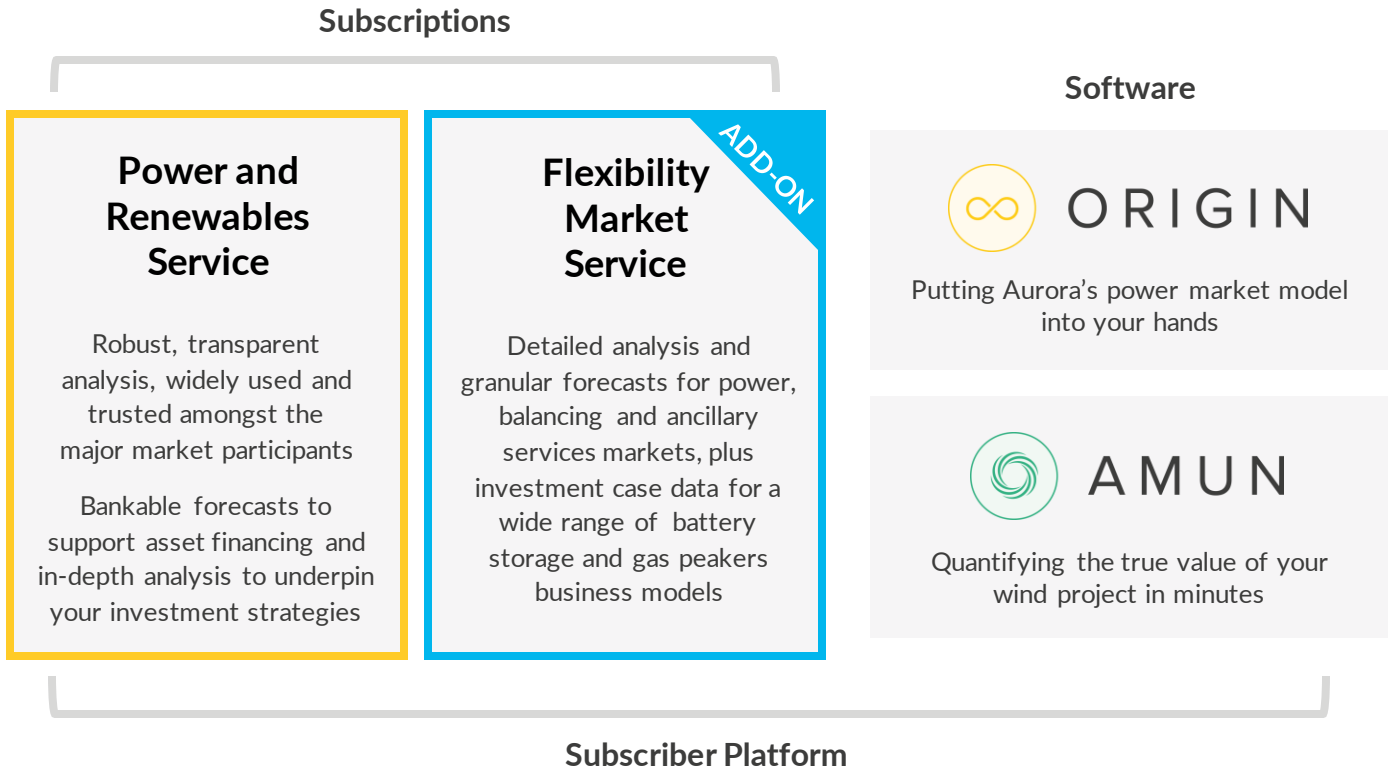


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